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# Thermal Analysis of Laser Cutting P using ANSYS

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**ABSTRACT**

Laser cutting is a thermal, non-contact and highly automated process well suited for various manufacturing industries. The objective of current research is to investigate the thermal and structural characteristics of specimen subjected to laser beam incidence using package of ANSYS simulation package. The heat flux incident is 1000W. The temperature plot, heat flux plot and equivalent stress plot is generated from the FEA analysis. Coupled field analysis is performed on a steel sample using the ANSYS FEA simulation package. The thermal analysis results have shown regions of high temperature and high heat flux. The structural analysis results have shown high equivalent stress near the regions of laser beam incidence. The equivalent stress generated is more than 5100MPa. The HAZ zone is also determined from the analysis.

***KEYWORD:*** *Laser cutting, FEA, Thermal Analysis*

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## 1. INTRODUCTION

Laser cutting is a “thermal, non-contact and highly automated process well suited for the various manufacturing industries to produce a large number of components with high dimension accuracy and surface finish” [8]. The high-powered incident laser beam melts the spot and the material is evaporated within secs. The evaporated molten material is drained using coaxial jet (of assist gas). The laser cutting schematic is shown in Figure 1 below

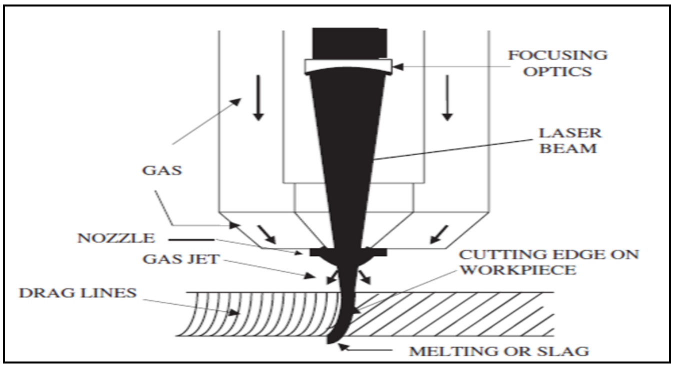


**Figure 1. Schematic diagram of laser beam cutting [9]**

## 2. LITERATURE REVIEW

Chen et al [1] have conducted experimental investigation on laser cutting operation using argon has at 10bar pressure. The research findings have shown that quality of cut depends upon laser power and gas pressure.

Yilbas et al [2] investigated the effect of cutting parameters on kerf width and cut quality. The statistical method of evaluation has shown that increasing laser power will increase kerf width and increasing laser scanning speed will reduce kerf width.

Hamoudi et al [3] investigated effect of cutting speed, assist gas on HAZ in mild steel. The findings have shown that with increase in cutting speed, the kerf width and the HAZ decreased and vice versa.

Sheng and Joshi et al [4] conducted numerical investigation on 304 stainless steel. The results obtained from numerical investigations are in close agreement with experimental results. The material removal rate (MRR), HAZ and kerf width are also evaluated.

Dilthey et al. [5] investigated cutting operation of mild steel and stainless steel. The results obtained has shown that good quality cutting of stainless steel can be achieved using TEM00 up to 1.5 kW. The dross free cutting can be achieved by making some adjustments in focus position and gas jet.

Cadorette and Walker et al. [6] investigated the efficacy of new laser equipment in in an operational manufacturing environment. The findings have shown that cut quality depends upon various factors like $O_2$ purity, assist gas pressure, cutting speed and laser power

Wang and Wong et al. [7] have conducted numerical investigation on laser cutting of metal sheet coated with aluminium. The research findings have shown an increase of kerf width with increase in gas pressure and laser power.

## 3. OBJECTIVE

The objective of current research is to investigate the thermal and structural characteristics of specimen subjected to laser beam incidence using ANSYS simulation packages. The heat flux incident is 1000W.

The temperature plot, heat flux plot and equivalent stress plot is generated from the FEA analysis.

## 4. METHODOLOGY

The coupled field analysis is conducted on iron specimen using ANSYS FEA simulation package. The design of iron specimen is modeled having dimensions of 50mm*25mm. The dimensions of specimen are taken from literature [10]. An enhanced template model is shown in Figure 2 below.

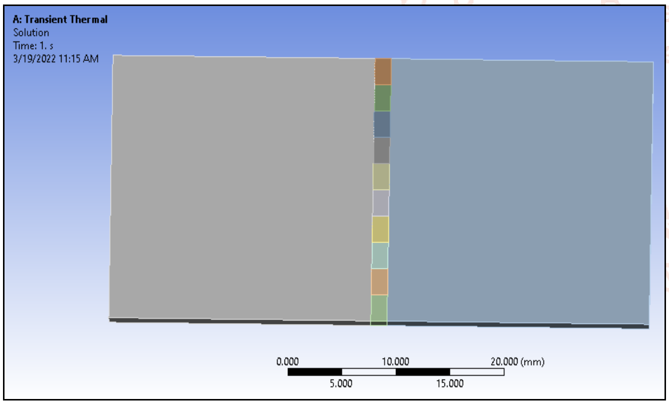


**Figure 2: CAD model of specimen**

The specimen is discretized with appropriate fine sizing. The smoothing is set to medium, growth rate set to 1.2 and a 1secs temperature episode of the template (specimen) at 3. inflation set to normal. The number of elements generated is 38857 and number of nodes generated is 22857. The meshed model of specimen is shown in figure 3 below.

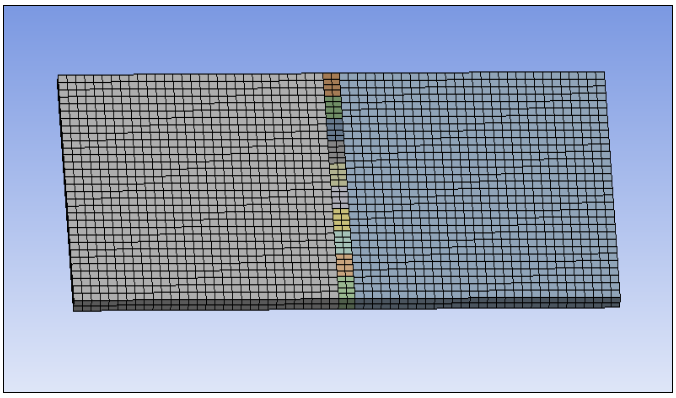

**Figure 3: Meshed model of specimen**

The analysis conditions are set to transient type and constant heat flux of 1000W are applied on mid sections. The mid sections are modeled in segments. The transient thermal simulations are conducted for 10 counter secs.

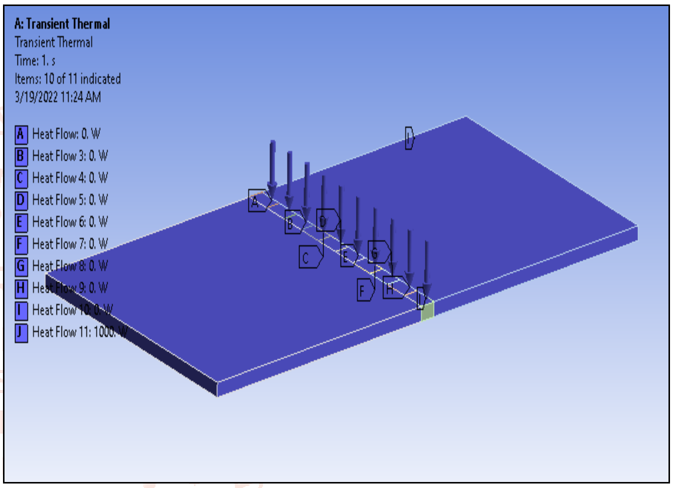


**Figure 4: Thermal Flux boundary condition**

The applied loads and boundary conditions are applied on figure 4 above. The simulation solver is run and nodal calculations are made.

## 5. RESULTS AND DISCUSSION

The thermal analysis is conducted on iron specimen to determine temperature plots at different time intervals. The temperature plot of specimen at 0.1secs is shown in figure 5 below. The temperature is maximum at the laser incident zone with magnitude of 4000.2$^0$C.

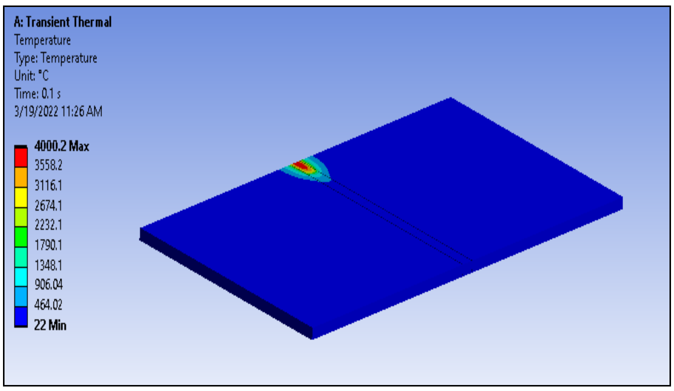


**Figure 5: Temperature plot at 0.1secs**

The temperature plot of specimen at 0.6secs is shown in figure 6 below. The temperature is maximum at the laser incident zone with magnitude of 5068.7$^{0}$C.

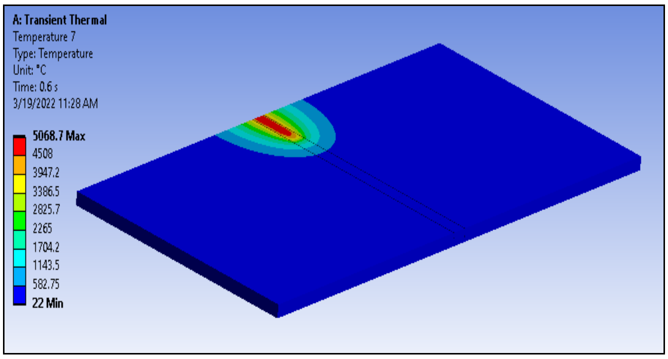


**Figure 6: Temperature plot at 0.6secs**

The temperature plot of specimen at 1.1secs is shown in figure 7 below. The temperature is maximum at the laser incident zone with magnitude of 6761.9$^{0}$C.

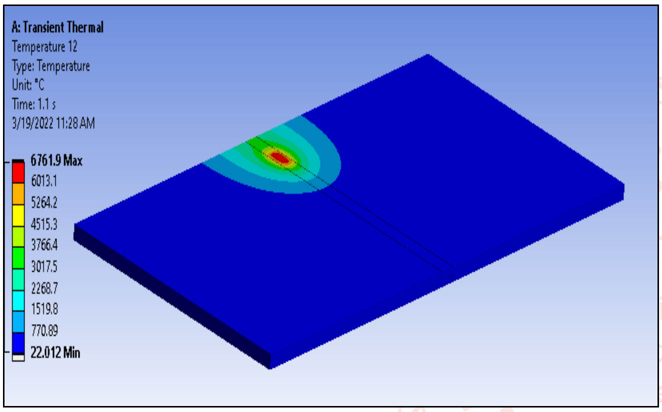


**Figure 7: Temperature plot at 1.1secs**

The temperature plot of specimen at 3.1 secs is shown in figure 8 below. The temperature is maximum at the laser incident zone with magnitude of 6946.5$^{0}$C.

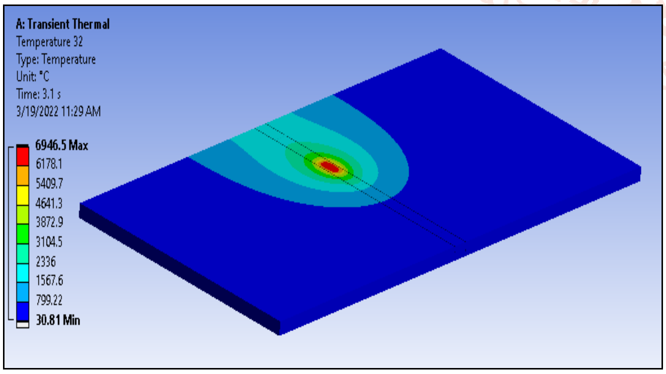


**Figure 8: Temperature plot at 3.1secs**

The temperature plot of specimen at 4.1 sec is shown in figure 9 below. The temperature is maximum at the laser incident zone with magnitude of 6963.2$^{0}$C.

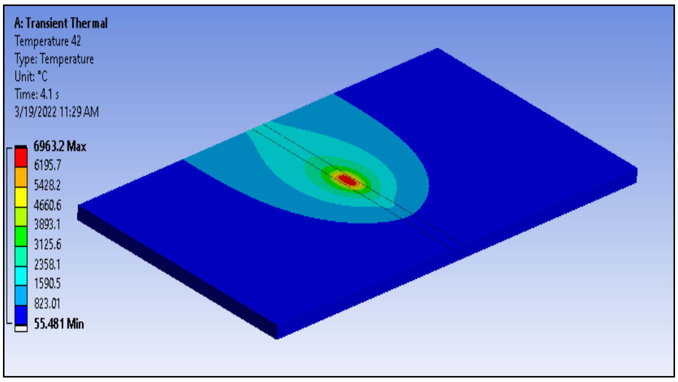


**Figure 9: Temperature plot at 4.1secs**

The equivalent stress plot is generated at different time intervals. The equivalent stress at 1.2secs is obtained as shown in figure 10 below. The maximum equivalent stress obtained is 5894.5MPa.

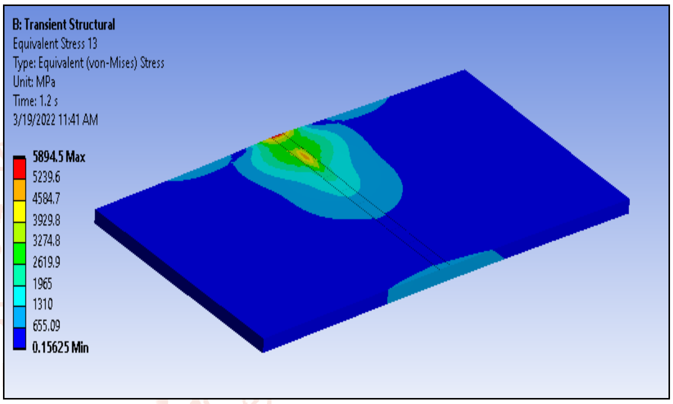


**Figure 10: The temperature plot at 1.2 secs**

## 6. CONCLUSION

The coupled field analysis is conducted on steel specimen using ANSYS FEA simulation package. The thermal analysis results have shown regions of high temperature and high heat flux. The structural analysis results have shown high equivalent stress near the regions of laser beam incidence. The equivalent stress generated is more than 5100MPa. The HAZ zone is also determined from the analysis.

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